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(71) Applicant: THE PROCTER & GAMBLE COMPANY [US/US]; One Procter & Gamble Plaza, Cincinnati, OH 45202 (US).

(72) Inventors: TROKHAN, Paul, Dennis; 1356 Warvel Road, Hamilton, OH 45013 (US). PHAN, Dean, Van; 6512 Tylers Crossing, West Chester, OH 45069 (US).

(74) Agents: REED , T., David et al.; The Procter & Gamble Company, 5299 Spring Grove Avenue, Cincinnati, OH 45217 (US).

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(54) Title: SOFT TISSUE PAPER CONTAINING AN OIL AND A POLYHYDROXY COMPOUND

(57) Abstract

Tissue paper having an enhanced bulk and tactile softness through incorporation of an effective amount of a polyhydroxy compound and an oil is disclosed. Preferably, from about 0.05 % to about 2.0 % of the polyhydroxy compound, on a dry fiber weight basis, and from about 0.05 % to about 2.0 % of an oil, on a dry fiber weight basis, are incorporated in the tissue paper. These nonionic compounds have high rates of retention when applied to wet tissue paper webs according to the process described herein. Tissue embodiments of the present invention may further comprise a quantity of strength additive, such as starch, to increase paper strength.

SOFT TISSUE PAPER CONTAINING AN OIL AND A POLYHYDROXY COMPOUND

FIELD OF THE INVENTION

This application relates to tissue papers, in particular pattern densified tissue papers, having an enhanced tactile sense of softness. This application particularly relates to tissue papers treated with certain oils and water-soluble polyhydroxy compounds.

BACKGROUND OF THE INVENTION

Paper webs or sheets, sometimes called tissue or paper tissue webs or sheets, find extensive use in modern society. These include such staple items as paper towels, facial tissues and sanitary (or toilet) tissues. These paper products can have various desirable properties, including wet and dry tensile strength, absorbency for aqueous fluids (e.g., wettability), low lint properties, desirable bulk, and softness. The particular challenge in papermaking has been to appropriately balance these various properties to provide superior tissue paper.

Although somewhat desirable for towel products, softness is a particularly important property for facial and toilet tissues. Softness is the tactile sensation perceived by the consumer who holds a particular paper product, rubs it across the skin, and crumples it within the hand. Such tactile perceivable softness can be characterized by, but is not limited to, friction, flexibility, and smoothness, as well as subjective descriptors, such as a feeling like velvet, silk or flannel. This tactile sensation is a combination of several physical properties, including the flexibility or stiffness of the sheet of paper, as well as the texture of the surface of the paper and the frictional properties of the sheet of paper.

Stiffness of paper is typically affected by efforts to increase the dry and/or wet tensile strength of the web. Increases in dry tensile

hydrophobic effects on the tissue paper, e.g., resulting in decreased absorbency and wettability.

Mechanical pressing operations are typically applied to tissue paper webs to dewater them and/or increase their tensile strength. Mechanical pressing can occur over the entire area of the paper web, such as in the case of conventional felt-pressed paper. More preferably, dewatering is carried out in such a way that the paper is pattern densified. Pattern densified paper has certain densified areas of relatively high fiber density, as well as relatively low fiber density, high bulk areas. Such high bulk pattern densified papers are typically formed from a partially dried paper web that has densified areas imparted to it by a foraminous fabric having a patterned displacement of knuckles. See, for example, U.S. Patent No. 3,301,746 (Sanford et al), issued January 31, 1967; U.S. Patent No. 3,994,771 (Morgan et al), issued November 30, 1976; and U.S. patent No. 4,529,480 (Trokhan), issued July 16, 1985.

Besides tensile strength and bulk, another advantage of such patterned densification processes is that ornamental patterns can be imprinted on the tissue paper. However, an inherent problem of patterned densification processes is that the fabric side of the tissue paper, i.e. the paper surface in contact with the foraminous fabric during papermaking, is sensed as rougher than the side not in contact with the fabric. This is due to the high bulk fields that form, in essence, protrusions outward from the surface of the paper. It is these protrusions that can impart a tactile sensation of roughness.

The softness of these compressed, and particularly patterned densified tissue papers, can be improved by treatment with various agents such as vegetable, animal or synthetic hydrocarbon oils, and especially polysiloxane materials typically referred to as silicone oils. See Column 1, lines 30-45 of U.S. Patent No. 4,959,125 (Spendel), issued September 25, 1990. These silicone oils impart a silky, soft feeling to the tissue paper. However, some silicone oils are hydrophobic and can adversely affect the surface wettability of the treated tissue paper, i.e. the treated tissue paper can float, thus causing disposal problems in sewer systems when flushed. Indeed, some silicone softened papers can require treatment with other surfactants to offset

It is also a further object of this invention to provide a process for making soft, absorbent tissue (i.e., facial and/or toilet tissue) and paper towel products.

These and other objects are obtained using the present invention, as will become readily apparent from a reading of the following disclosure.

SUMMARY OF THE INVENTION

The present invention provides soft, absorbent tissue paper products. Briefly, the soft tissue paper products comprise:

a) wet-laid cellulosic fibers;

b) from about 0.01% to about 5% of a water soluble polyhydroxy compound, based on the dry fiber weight of said tissue paper; and

c) from about 0.01% to about 5% of an oil selected from the group consisting of petroleum-based oils, polysiloxane-based oils, and mixtures thereof, based on the dry fiber weight of said tissue paper;

wherein said tissue paper has a basis weight of from about 10 to about 65 g/m2 and a density of less than about 0.60 g/cc, said polyhydroxy compound and said oil having being applied to a least one surface of a wet tissue paper web.

The present invention further relates to a process for making these softened tissue papers. The process includes the steps:

a) wetlaying an aqueous slurry containing cellulosic fibers to form a web;

b) applying to said web at fiber consistency of from about 10% to about

process of the present invention of adding treatment chemicals to a pattern densified tissue paper web.

DETAILED DESCRIPTION OF THE INVENTION

While this specification concludes with claims particularly pointing out and distinctly claiming the subject matter regarded as the invention, it is believed that the invention can be better understood from a reading of the following detailed description and of the appended examples.

As used herein, the term "comprising" means that the various components, ingredients, or steps, can be conjointly employed in practicing the present invention. Accordingly, the term "comprising" encompasses the more restrictive terms "consisting essentially of" and "consisting of".

As used herein, the terms tissue paper web, paper web, web, paper sheet and paper product all refer to sheets of paper made by a process comprising the steps of forming an aqueous papermaking furnish, depositing this furnish on a foraminous surface, such as a Fourdrinier wire, and removing the water from the furnish as by gravity or vacuum-assisted drainage, with or without pressing, and by evaporation.

As used herein, an aqueous papermaking furnish is an aqueous slurry of papermaking fibers and the chemicals described hereinafter.

As used herein, the term "consistency" refers to the weight percentage of the cellulosic paper making fibers (i.e., pulp) in the wet tissue web. It is expressed as a weight percentage of this fibrous material, in the wet web, in terms of air dry fiber weight divided by the weight of the wet web.

The first step in the process of this invention is the forming of an aqueous papermaking furnish. The furnish comprises papermaking fibers (hereinafter sometimes referred to as wood pulp). It is anticipated that wood pulp in all its varieties will normally comprise the papermaking fibers used in this invention. However, other cellulose

is available commercially from the Union Carbide Company of Danbury, Connecticut under the tradename "PEG-400".

(B) Oils

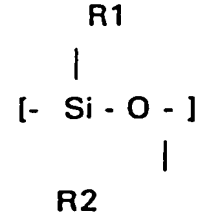
The present invention contains as an essential component from about 0.01% to about 5.0%, preferably from 0.05% to about 2.0%, more preferably from about 0.1% to about 1.0%, by weight of an oil selected from the group consisting of petroleum-based oils, polysiloxane-based oils, and mixtures thereof, based on the dry fiber weight of the tissue paper.

Petroleum-based oils

As used herein, the term petroleum-based oils refers to viscous mixtures of hydrocarbons having from about 16 to about 32 carbon atoms. Preferably, the petroleum-based oil is a petroleum-based turbine oil comprised primarily of saturated hydrocarbons. An example of a preferred petroleum-based turbine oil for use in the present invention is known as "Regal Oil". As used herein, the term "Regal Oil" refers to the compound which is comprised of approximately 87% saturated hydrocarbons and approximately 12.6% aromatic hydrocarbons with traces of additives, manufactured as product number R & O 68 Code 702 by the Texaco Oil Company of Houston, Texas.

Polysiloxane-based oils

In general suitable polysiloxane materials for use in the present invention include those having monomeric siloxane units of the following structure:



Compounds, pp 181-217, distributed by Petrarch Systems, Inc., 1984, which contains an extensive listing and description of polysiloxanes in general.

C. Tissue Papers

The present invention is applicable to tissue paper in general, including but not limited to conventionally felt-pressed tissue paper; pattern densified tissue paper such as exemplified in the aforementioned U.S. Patent by Sanford-Sisson and its progeny; and high bulk, uncompacted tissue paper such as exemplified by U.S. Patent No. 3,812,000, Salvucci, Jr., issued May 21, 1974. The tissue paper may be of a homogenous or multilayered construction; and tissue paper products made therefrom may be of a single-ply or multi-ply construction. Tissue structures formed from layered paper webs are described in U.S. Patent No. 3,994,771, Morgan, Jr. et al. issued November 30, 1976, U.S. Patent No. 4,300,981, Carstens, issued November 17, 1981, U.S. Patent No. 4,166,001, Dunning et al., issued August 28, 1979, and European Patent Publication No. 0 613 979 A1, Edwards et al., published September 7, 1994, all of which are incorporated herein by reference. In general, a wet-laid composite, soft, bulky and absorbent paper structure is prepared from two or more layers of furnish which are preferably comprised of different fiber types. The layers are preferably formed from the deposition of separate streams of dilute fiber slurries, the fibers typically being relatively long softwood and relatively short hardwood fibers as used in tissue papermaking, upon one or more endless foraminous screens. The layers are subsequently combined to form a layered composite web. The layered web is subsequently caused to conform to the surface of an open mesh drying/imprinting fabric by the application of a fluid to force to the web and thereafter thermally predried on said fabric as part of a low density papermaking process. The layered web may be stratified with respect to fiber type or the fiber content of the respective layers may be essentially the same. The tissue paper preferably has a basis weight of between 10 g/m2 and about 65 g/m2, and density of about 0.60 g/cc or less. Preferably, basis weight will be below about 35 g/m2 or less; and density will be about 0.30 g/cc or

Preferred processes for making pattern densified tissue webs are disclosed in U.S. Patent No. 3,301,746, issued to Sanford and Sisson on January 31, 1967, U.S. Patent No. 3,974,025, issued to Peter G. Ayers on August 10, 1976, and U.S. Patent No. 4,191,609, issued to Paul D. Trokhan on March 4, 1980, and U.S. Patent No. 4,637,859, issued to Paul D. Trokhan on January 20, 1987, U.S. Patent No. 4,942,077 issued to Wendt et al. on July 17, 1990, European Patent Publication No. 0 617 164 A1, Hyland et al., published September 28, 1994, European Patent Publication No. 0 616 074 A1, Hermans et al., published September 21, 1994; all of which are incorporated herein by reference.

In general, pattern densified webs are preferably prepared by depositing a papermaking furnish on a foraminous forming wire such as a Fourdrinier wire to form a wet web and then juxtaposing the web against an array of supports. The web is pressed against the array of supports, thereby resulting in densified zones in the web at the locations geographically corresponding to the points of contact between the array of supports and the wet web. The remainder of the web not compressed during this operation is referred to as the high bulk field. This high bulk field can be further dedensified by application of fluid pressure, such as with a vacuum type device or a blow-through dryer, or by mechanically pressing the web against the array of supports. The web is dewatered, and optionally predried, in such a manner so as to substantially avoid compression of the high bulk field. This is preferably accomplished by fluid pressure, such as with a vacuum type device or blow-through dryer, or alternately by mechanically pressing the web against an array of supports wherein the high bulk field is not compressed. The operations of dewatering, optional predrying and formation of the densified zones may be integrated or partially integrated to reduce the total number of processing steps performed. Subsequent to formation of the densifled zones, dewatering, and optional predrying, the web is dried to completion, preferably still avoiding mechanical pressing. Preferably, from about 8% to about 55% of the tissue paper surface comprises densified knuckles having a relative density of at least 125% of the density of the high bulk field.

4,208,459, issued to Henry E. Becker, Albert L. McConnell, and Richard Schutte on June 17, 1980, both of which are incorporated herein by reference. In general, uncompacted, non pattern densified tissue paper structures are prepared by depositing a papermaking furnish and a debonding agent on a foraminous forming wire such as a Fourdrinier wire to form a wet web, draining the web and removing additional water without mechanical compression until the web has a fiber consistency of at least 80%, and creping the web. Water is removed from the web by vacuum dewatering and thermal drying. The resulting structure is a soft but weak high bulk sheet of relatively uncompacted fibers. Bonding material is preferably applied to portions of the web prior to creping.

Compacted non-pattern-densified tissue structures are commonly known in the art as conventional tissue structures. In general, compacted, non-pattern-densified tissue paper structures are prepared by depositing a papermaking furnish on a foraminous wire such as a Fourdrinier wire to form a wet web, draining the web and removing additional water with the aid of a uniform mechanical compaction (pressing) until the web has a consistency of 25-50%, transferring the web to a thermal dryer such as a Yankee and creping the web. Overall, water is removed from the web by vacuum, mechanical pressing and thermal means. The resulting structure is strong and generally of singular density, but very low in bulk, absorbency and in softness.

The tissue paper web of this invention can be used in any application where soft, absorbent tissue paper webs are required. Particularly advantageous uses of the tissue paper web of this invention are in paper towel, toilet tissue and facial tissue products. For example, two tissue paper webs of this invention can be embossed and adhesively secured together in face to face relation as taught by U.S. Pat. No. 3,414,459, which issued to Wells on December 3, 1968 and which is incorporated herein by reference, to form 2-ply paper towels.

In the following discussion, wherein reference is made to the several figures, certain preferred embodiments of processes for making the tissue sheet structures of the present invention are described.

applied to the papermaking belt 10 through cleaning showers 102 and 102a.

An example of an especially preferred emulsion composition contains water, a petroleum-based oil known as "Regal Oil", distearyldimethylammonium chloride, cetyl alcohol and a polyhydroxy compound (such as glycerol). distearyldimethylammonium chloride is sold under the trade name ADOGEN TA 100 by the Witco Corporation of Mapleton, Illinois. Hereinafter, distearyldimethyl-ammonium chloride will be referred to as ADOGEN for convenience. ADOGEN is used in the emulsion as a surfactant to emulsify or stabilize the oil particles (e.g., Regal Oil, Polysiloxane Oil) in the water.

The purpose of the Regal Oil in the composition described above is to serve as a "release emulsion." By "release emulsion," it is meant that it provides a coating on the papermaking belt 10 so the paper formed releases from (or does not stick to) the same after the steps of the present invention have been performed to the paper web.

As referred to herein, the term "surfactant" refers to a surface active agent, one portion of which is hydrophilic, and another portion of which is hydrophobic, which migrates to the interface between a hydrophilic substance and a hydrophobic substance to stabilize the two substances.

As used herein, "cetyl alcohol" refers to a C16 linear fatty alcohol. Cetyl alcohol is manufactured by The Procter & Gamble Company of Cincinnati, Ohio. Cetyl alcohol, like ADOGEN is used as a surfactant in the emulsion utilized in the preferred embodiment of the present invention.

The relative percentages of the composition of the emulsion, in the preferred embodiment of the same are set out in the following table:

Component	Volume (gal.)	Volume (lbs.)	Weight (%)
Water	259	4,320	62.2
REGAL OIL	55	422	6.1
ADOGEN	N/A	24	0.3

Analytical and Testing Procedures

Analysis of the amounts of treatment chemicals herein retained on tissue paper webs can be performed by any method accepted in the applicable art. For example, the level of the polyhydroxy compound retained by the tissue paper can be determined by solvent extraction of the polyhydroxy compound with a solvent. In some cases, additional procedures may be necessary to remove interfering compounds from the polyhydroxy species of interest. For instance, the Weibull solvent extraction method employs a brine solution to isolate polyethylene glycols from nonionic surfactants (Longman, G.F., The Analysis of Detergents and Detergent Products Wiley Interscience, New York, 1975, p. 312). The polyhydroxy species could then be analyzed by spectroscopic or chromatographic techniques. For example, compounds with at least six ethylene oxide units can typically be analyzed spectroscopically by the Ammonium cobaltothiocyanate method (Longman, G.F., The Analysis of Detergents and Detergent Products. Wiley Interscience, New York, 1975, p. 346). Gas chromatography techniques can also be used to separate and analyze polyhydroxy type compounds. Graphitized poly(2,6-diphenyl-p-phenylene oxide) gas chromatography columns have been used to separate polyethylene glycols with the number of ethylene oxide units ranging from 3 to 9 (Alltech chromatography catalog, number 300, p. 158). The level of polysiloxane-based oil or petroleum-based oil retained by the tissue paper can be determined by solvent extraction of the oil with an organic solvent followed by atomic absorption spectroscopy to determine the level of the oil in the extract

The level of nonionic surfactants, such as alkyl glycosides, can be determined by chromatographic techniques. Bruns reported a High Performance Liquid chromatography method with light scattering detection for the analysis of alkyl glycosides (Bruns, A., Waldhoff, H., Winkle, W., Chromatographia, vol. 27, 1989, p. 340). A Supercritical Fluid Chromatography (SFC) technique was also described in the analysis of alkyl glycosides and related species (Lafosse, M., Rollin, P., Elfakir, c., Morin-Allory, L., Martens, M., Dreux, M., Journal of chromatography, vol. 505, 1990, p. 191). The level of anionic

the samples, and the subject is required to choose one of them on the basis of tactile softness. The result of the test is reported in what is referred to as Panel Score Unit (PSU). With respect to softness testing to obtain the softness data reported herein in PSU, a number of softness panel tests are performed. In each test ten practiced softness judges are asked to rate the relative softness of three sets of paired samples. The pairs of samples are judged one pair at a time by each judge: one sample of each pair being designated X and the other Y. Briefly, each X sample is graded against its paired Y sample as follows:

1. a grade of plus one is given if X is judged to may be a little softer than Y, and a grade of minus one is given if Y is judged to may be a little softer than X;
2. a grade of plus two is given if X is judged to surely be a little softer than Y, and a grade of minus two is given if Y is judged to surely be a little softer than X;
3. a grade of plus three is given to X if it is judged to be a lot softer than Y, and a grade of minus three is given if Y is judged to be a lot softer than X; and, lastly:
4. a grade of plus four is given to X if it is judged to be a whole lot softer than Y, and a grade of minus 4 is given if Y is judged to be a whole lot softer than X.

The grades are averaged and the resultant value is in units of PSU. The resulting data are considered the results of one panel test. If more than one sample pair is evaluated then all sample pairs are rank ordered according to their grades by paired statistical analysis. Then, the rank is shifted up or down in value as required to give a zero PSU value to which ever sample is chosen to be the zero-base standard. The other samples then have plus or minus values as determined by their relative grades with respect to the zero base standard. The

average and standard deviation taken for the 5 sets of data. The units of the measurement are seconds. The water must be changed after the 5 sets of 5 balls (total = 25 balls) have been tested. copious cleaning of the beaker may be necessary if a film or residue is noted on the inside wall of the beaker.

Another technique to measure the water absorption rate is through pad sink measurements. After conditioning the tissue paper of interest and all controls for a minimum of 24 hours at 22 to 24 °C and 48 to 52% relative humidity (Tappi method #T402OM-88), a stack of 5 to 20 sheets of tissue paper is cut to dimensions of 2.5" to 3.0". The cutting can take place through the use of dye cutting presses, a conventional paper cutter, or laser cutting techniques. Manual scissors cutting is not preferred due to both the irreproducibility in handling of the samples, and the potential for paper contamination.

After the paper sample stack has been cut, it is carefully placed on a wire mesh sample holder. The function of this holder is to position the sample on the surface of the water with minimal disruption. This holder is circular in shape and has a diameter of approximately 4.2". It has five straight and evenly spaced metal wires running parallel to one another and across to spot welded points on the wire's circumference. The spacing between the wires is approximately 0.7". This wire mesh screen should be clean and dry prior to placing the paper on its surface. A 3 liter beaker is filled with about 3 liters of distilled water stabilized at a temperature of 22 to 24 °C. After insuring oneself that the water surface is free of any waves or surface motion, the screen containing the paper is carefully placed on top of the water surface. The screen sample holder is allowed to continue downward after the sample floats on the surface so the sample holder screen handle catches on the side of the beaker. In this way, the screen does not interfere with the water absorption of the paper sample. At the exact moment the paper sample touches the surface of the water, a timer is started. The timer is stopped after the paper stack is completely wetted out. This is easily visually observed by noting a transition in the paper color from its dry white color to a darker grayish coloration upon complete wetting. At the instant of complete wetting,

the caliper, with the appropriate unit conversions incorporated therein to convert to g/cc. Caliper of the tissue paper, as used herein, is the thickness of the preconditioned (23 +/-1°C, 50 +/- 2% RH for 24 hours according to a TAPPI Method #T4020M-88) paper when subjected to a compressive load of 95 g/in2 (15.5 g/cm2). The caliper is measured with a Thwing-Albert model 89-II thickness tester (Thwing-Albert Co. of Philadelphia, PA). The basis weight of the paper is typically determined on a 4"X4" pad which is 8 plies thick. This pad is preconditioned according to Tappi Method #T402OM-88 and then the weight is measured in units of grams to the nearest ten-thousanths of a gram. Appropriate conversions are made to report the basis weight in units of pounds per 3000 square feet.

D. Lint

Dry lint

Dry lint can be measured using a Sutherland Rub Tester, a piece of black felt (made of wool having a thickness of about 2.4 mm and a density of about 0.2 gm/cc. Such felt material is readily available form retail fabric stores such as Hancock Fabric), a four pound weight and a Hunter Color meter. The Sutherland tester is a motor-driven instrument which can stroke a weighted sample back and forth across a stationary sample. The piece of black felt is attached to the four pound weight. The tissue sample is mounted on a piece of cardboard (Crescent #300 obtained from Cordage of Cincinnati, OH.) The tester then rubs or moves the weighted felt over a stationary tissue sample for five strokes. The load applied to the tissue during rubbing is about 33.1 gm/sq. cm.. The Hunter Color L value of the black felt is determined before and after rubbing. The difference in the two Hunter Color readings constitutes a measurement of dry linting. Other methods known in the prior arts for measuring dry lint also can be used.

Wet lint

A suitable procedure for measuring the wet linting property of tissue samples is described in U.S. Patent No. 4,950,545; issued to Walter et al., on August 21, 1990, and incorporated herein by reference. The procedure essentially involves passing a tissue sample through two steel rolls, one of which is partially submerged in a water bath. Lint from the tissue sample is transferred to the steel roll which is

More preferably the hydrocarbyl chain length for liquid compositions is from about 16 to about 18 carbon atoms and for solid compositions from about 10 to about 14 carbon atoms. In the general formula for the ethoxylated nonionic surfactants herein, Y is typically -O-, -C(O)O-, -C(O)N(R)-, or -C(O)N(R)R-, in which R2, and R, when present, have the meanings given herein before, and/or R can be hydrogen, and z is at least about 8, preferably at least about 10-11. Performance and, usually, stability of the softener composition decrease when fewer ethoxylate groups are present.

The nonionic surfactants herein are characterized by an HLB (hydrophilic-lipophilic balance) of from about 7 to about 20, preferably from about 8 to about 15. Of course, by defining R2 and the number of ethoxylate groups, the HLB of the surfactant is, in general, determined. However, it is to be noted that the nonionic ethoxylated surfactants useful herein, for concentrated liquid compositions, contain relatively long chain R2 groups and are relatively highly ethoxylated. While shorter alkyl chain surfactants having short ethoxylated groups may possess the requisite HLB, they are not as effective herein.

Examples of nonionic surfactants follow. The nonionic surfactants of this invention are not limited to these examples. In the examples, the integer defines the number of ethoxyl (EO) groups in the molecule.

Linear Alkoxylated Alcohols

a. Linear, Primary Alcohol Alkoxylates

The deca-, undeca-, dodeca-, tetradeca-, and pentadeca-ethoxylates of n-hexadecanol, and n-octadecanol having an HLB within the range recited herein are useful wetting agents in the context of this invention. Exemplary ethoxylated primary alcohols useful herein as the viscosity/dispersibility modifiers of the compositions are n-C18EO(10); and n-C10EO(11). The ethoxylates of mixed natural or synthetic alcohols in the "oleyl" chain length range are also useful herein. Specific examples of such materials include oleylalcohol-EO(11), oleylalcohol-EO(18), and oleylalcohol -EO(25).

The above ethoxylated nonionic surfactants are useful in the present compositions alone or in combination, and the term "nonionic surfactant" encompasses mixed nonionic surface active agents.

The level of surfactant, if used, is preferably from about 0.01% to about 2.0% by weight, based on the dry fiber weight of the tissue paper. The surfactants preferably have alkyl chains with eight or more carbon atoms. Exemplary anionic surfactants are linear alkyl sulfonates, and alkylbenzene sulfonates. Exemplary nonionic surfactants are alkylglycosides including alkylglycoside esters such as Crodesta SL-40 which is available from Croda, Inc. (New York, NY); alkylglycoside ethers as described in U.S. Patent No. 4.011,389, issued to W. K. Langdon, et al. on March 8, 1977; and alkylpolyethoxylated esters such as Pegosperse 200 ML available from Glyco Chemicals, Inc. (Greenwich, CT) and IGEPAL RC-520 available from Rhone Poulenc Corporation (Cranbury, N.J.).

B. Strength additives:

Other types of chemicals which may be added, include the strength additives to increase the dry and wet tensile strength of the tissue webs. The present invention may contain as an optional component an effective amount, preferably from about 0.01% to about 3.0%, more preferably from about 0.2% to about 2.0% by weight, on a dry fiber weight basis, of a water-soluble strength additive resin. These strength additive resins are preferably selected from the group consisting of dry strength resins, permanent wet strength resins, temporary wet strength resins, and mixtures thereof.

(a) Dry strength additives

The dry strength additives are preferably selected from the group consisting of carboxymethyl cellulose resins, starch based resins and mixtures thereof. Examples of preferred dry strength additives include carboxymethyl cellulose, and cationic polymers from the ACCO chemical family such as ACCO 711 and ACCO 514, with ACCO chemical family being most preferred. These materials are available commercially from the American Cyanamid Company of Wayne, New Jersey.

Petrovich on August 12, 1975; 4,129,528 issued to Petrovich on December 12, 1978; 4,147,586 issued to Petrovich on April 3, 1979; and 4,222,921 issued to Van Eenam on September 16, 1980, all incorporated herein by reference.

Other water-soluble cationic resins useful herein are the polyacrylamide resins such as those sold under the Parez trademark, such as Parez 631NC, by American Cyanamid Company of Stanford, Connecticut. These materials are generally described in U.S. Pat. Nos. 3,556,932 issued to Coscia et al . on January 19, 1971; and 3,556,933 issued to Williams et al . on January 19, 1971, all incorporated herein by reference.

Other types of water-soluble resins useful in the present invention include acrylic emulsions and anionic styrene-butadiene latexes. Numerous examples of these types of resins are provided in U.S. Patent No. 3,844,880, Meisel, Jr. et al ., issued October 29, 1974, incorporated herein by reference.

Still other water-soluble cationic resins finding utility in this invention are the urea formaldehyde and melamine formaldehyde resins. These polyfunctional, reactive polymers have molecular weights on the order of a few thousand. The more common functional groups include nitrogen containing groups such as amino groups and methylol groups attached to nitrogen.

Although less preferred, polyethylenimine type resins find utility in the present invention.

More complete descriptions of the aforementioned water-soluble resins, including their manufacture, can be found in TAPPI Monograph Series No. 29, **Wet Strength In Paper and Paperboard**, Technical Association of the Pulp and Paper Industry (New York; 1965), incorporated herein by reference. As used herein, the term "permanent wet strength resin" refers to a resin which allows the paper sheet, when placed in an aqueous medium, to keep a majority of its initial wet strength for a period of time greater than at least two minutes.

(c) Temporary wet strength additives

The above-mentioned wet strength additives typically result in paper products with permanent wet strength, i.e., paper which when placed in an aqueous medium retains a substantial portion of its initial wet strength over time. However, permanent wet strength in some

NSK (Northern Softwood Kraft (such as Grand Prairie from Weyerhaeuser Corporation of Tacoma Washington)) is made up in a conventional re-pulper. A 2% solution of the temporary wet strength resin (i.e., National starch 78-0080 marketed by National Starch and Chemical corporation of New-York, NY) is added to the NSK stock pipe at a rate of 0.75% by weight of the dry fibers. The adsorption of the temporary wet strength resin onto NSK fibers is enhanced by an in-line mixer. The NSK slurry is diluted to about 0.2% consistency at the fan pump. A 3% by weight aqueous slurry of Eucalyptus (such as Aracruz of Brazil) fibers is made up in a conventional re-pulper. The Eucalyptus slurry is diluted to about 0.2% consistency at the fan pump. The individual furnish components are sent to separate layers (i.e., Euc. to the outer layers and NSK in the center layer) in the head box and deposited onto a Foudrinier wire to form a three-layer embryonic web. Dewatering occurs through the Fourdrinier wire and is assisted by a deflector and vacuum boxes. The Fourdrinier wire is of a 5-shed, satin weave configuration having 33 machine-direction and 30 cross-machine-direction monofilaments per centimeter, respectively. The embryonic wet web is transferred from the Fourdrinier wire, at a fiber consistency of about 18% at the point of transfer, to a second papermaking belt. The second papermaking belt is an endless belt having the preferred network surface and deflection conduits. The papermaking belt is made by forming a photo-polymeric network on a foraminous woven element made of polyester and having 14 (MD) by 12 (CD) filaments per centimeter in a four shed dual layer design according to the process disclosed in U.S. No. 5,334,289 issued to Trokhan. The filaments are about .22 mm in diameter machine-direction and .28 mm in diameter cross-machine-direction. The photosensitive resin used in the process is Merigraph resin EPD1616C, a methacrylated-urethane resin marketed by Hercules, Incorporated, Wilmington, Delaware. The papermaking belt is about 1.1 mm thick.

The embryonic web is carried on the papermaking belt past the vacuum dewatering box, through blow-through predryers after which the web is transferred onto a Yankee dryer. The other process and machine conditions are listed below. The fiber consistency is about 27% after the vacuum dewatering box and, by the action of the predryers, about 65% prior to transfer onto the Yankee dryer; creping

CLAIMS

1. Tissue paper characterized in that it comprises:

a) wet-laid cellulosic fibers;

b) from 0.01% to 5% of a water soluble polyhydroxy compound, based on the dry fiber weight of said tissue paper, wherein said polyhydroxy compound is preferably selected from glycerol, polyglycerols having a weight average molecular weight from 150 to 800, polyoxyethylene glycol and polyoxypropylene glycol or polyoxyethylene / polyoxypropylene glycol copolymers having a weight average molecular weight from 200 to 1000, and mixtures thereof; and

c) from 0.01% to 5% of an oil selected from petroleum-based oils, polysiloxane-based oils, and mixtures thereof, based on the dry fiber weight of said tissue paper, wherein said petroleum-based oil is preferably a petroleum-based turbine oil comprised primarily of saturated hydrocarbons;

wherein said tissue paper has a basis weight of from 10 to 65 g/m^2 and a density of less than 0.60 g/cc.

2. The tissue paper of Claim 1 wherein said polyhydroxy compound is a polyoxyethylene glycol having a weight average molecular weight from 200 to 1000, more preferably a weight average molecular weight from 200 to 600.

3. The tissue paper of Claim 1 wherein said polyhydroxy compound is a mixture of glycerol and polyoxyethylene glycol having a weight average molecular weight from 200 to 1000.

4. The tissue paper of Claim 1 wherein said polyhydroxy compound is a mixture of polyglycerols having a weight average molecular weight from 150 to 800 and polyoxyethylene glycol having a weight average molecular weight from 200 to 1000.

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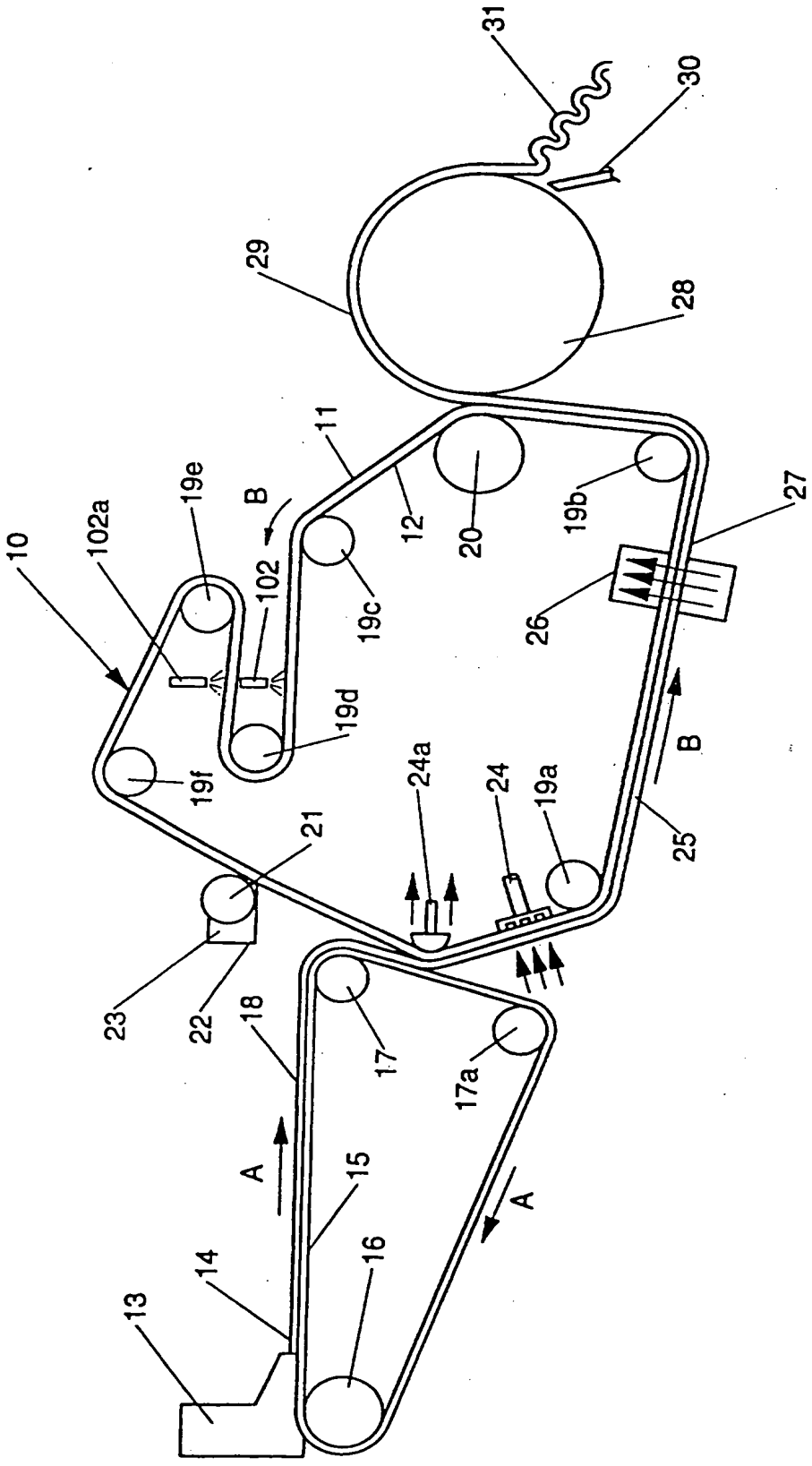
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(73) **Proprietor(s):**

THE PROCTER & GAMBLE COMPANY
One Procter & Gamble Plaza
Cincinnati,
Ohio 45202
US

(72) **Inventor(s):**

TROKHAN, Paul, Dennis
1356 Warvel Road
Hamilton, OH 45013
US

PHAN, Dean, Van
6512 Tylers Crossing
West Chester, OH 45069
US

(74) **Representative(s):**

Hirsch, Uwe Thomaset al
Procter & Gamble European Service GmbH,
Sulzbacher Strasse 40-50
65824 Schwalbach am Taunus
DE

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